

# **Enhanced Ocean Climate Products from NCEP**

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## **Project Summary**

The impact of new observational data sets on the current operational GODAS was examined through a series of data assimilation experiments. Use of ARGO salinity data dramatically improved the equatorial current structure and removed major climatological biases. Altimetry data was prepared for operational use and will be implemented in 2007. Two evolutionary improvements into NCEP's 3DVAR GODAS were developed and tested. Extension of the analysis to 2200 m (from 750 m) dramatically reduced the temperature bias in GODAS analyses. Preliminary work with MOMv4 was completed in preparation for making it the basis of new versions of the GODAS and the CFS.

## **1.0 Progress in FY06**

The work in FY06 focused on three areas. First, we examined the impact of new observational data sets on the current operational GODAS and prepared for the operational use of altimetry data, second, we developed two evolutionary improvements into our 3DVAR assimilation system, and third, we completed preliminary work with MOMv4 in preparation for making it the basis of new versions of the GODAS and the CFS.

### **1.1 New observational data sets for GODAS**

All work has been completed to make the assimilation of Jason-1 altimetry part of the operational GODAS. NCEP is currently installing the next generation of its IBM super computers and changes to the operational suite are on hold. When the computer upgrade is complete after the first of the year, the assimilation of altimetry will become operational. In the meantime, the new GODAS is run daily in an operational-like mode and has functioned without fault since June. Because the new version of GODAS continues to assimilate profile data, any loss of altimetry data, such as has occurred recently, does not cause GODAS to fail.

Our experimentation with the assimilation of Argo salinity data in place of the synthetic salinity data that is used in the operational GODAS has produced an interesting and surprising result. Mean biases in the equatorial surface currents have been an ongoing problem in GODAS and in its predecessor, the Pacific Ocean data assimilation system. In the GODAS, this has taken the form of a westward bias in the far western Pacific and an eastward bias in most of the central Pacific. To test the impact of Argo salinity, we have conducted an experiment in which we assimilated only Argo and XBT profile data. Observed Argo salinity profiles were paired with the Argo temperature profiles and synthetic salinity profiles with the XBTs. In this experiment no TAO mooring data were assimilated so as to allow the Argo salinity profiles to dominate in the tropical Pacific.

**When we compared the equatorial currents in this experiment for the year 2005 with ADCP observations the results were unambiguous: the mean current biases of the standard GODAS were gone and even the complex vertical structure of the currents in the western Pacific were well reproduced. The message appears clear: to get the surface currents right, you first have to get the upper ocean salinity right.**

The challenge now is to try to improve our method of computing synthetic salinity to take advantage of this result in the years prior to the Argo era. This will be one of our tasks for FY07.

The altimetry and Argo salinity work are described in more detail in Behringer (2007).

## **1.2 Improvements to the 3DVAR assimilation system**

The operational 3DVAR assimilation system is univariate in temperature and salinity. As part of the FY06 work plan we developed a version of GODAS that is multivariate in the *U* and *V* components of velocity. It was motivated by recent published reports that suggested that a multivariate scheme provides a better representation of ocean currents through a balancing geostrophic relationship. After some tuning of the method to deal with the fact that geostrophy breaks down at the equator and the fact that near-equatorial currents are not strictly linear, we ran a multivariate experiment for the years 2000-2005. The results of the experiment showed much improved surface currents in the tropical Pacific as compared to those in the operational GODAS. The improvement, however, was not as impressive as in the case where Argo salinity data were assimilated (see 1.1 above).

Another, simpler improvement to the operational 3DVAR assimilation system was also tested in FY06. The standard GODAS assimilates data only in the upper 750 meters and we wanted to test the effect of extending the assimilation much deeper, to 2200 meters. The idea was to take full advantage of the deeper Argo profiles. We also wanted to see whether we could extend the deep assimilation backward in time by using deep temperature climatology in the years prior to the availability of Argo. We did a deep assimilation run extending from 1979 through 2005. The results of that experiment were satisfying. In the standard GODAS at 1200 meters on the equator there is a steady drift over time toward warmer temperatures in the Indian and Pacific Oceans and toward colder temperatures in the Atlantic Ocean. In the GODAS experiment with deep assimilation, the temperature drifts in the Indian and Pacific Oceans have been eliminated and the cold drift in the Atlantic Ocean has been replaced by a long-term warming trend. Comparison of the GODAS results with independent CTD sections in the Atlantic Ocean, shows that the deep assimilation both removes a deep temperature bias in the standard GODAS and correctly captures the long term trend.

The multivariate and deep assimilation modifications to the 3DVAR system are described in more detail in Behringer (2007).

## **1.3 Preparation of MOMv4 for new versions of GODAS and CFS**

We have completed a fully global configuration of MOMv4 that will be used in the next versions of the GODAS and the CFS. It has been spun-up as a forced model and we have gained some understanding of its performance. Incorporating it into the new versions of GODAS and CFS will be part of the work for FY07.

## **Reference**

Behringer, David W., 2007: The Global Ocean Data Assimilation System (GODAS) at NCEP. *Eleventh Symposium on Integrated Observing and Assimilation Systems for Atmosphere, Oceans, and Land Surface, AMS 87th Annual Meeting, H.B. Gonzalez Convention Center, San Antonio, Texas, 12pp.* (a PDF version is available from [http://ams.confex.com/ams/87ANNUAL/techprogram/programexpanded\\_393.htm](http://ams.confex.com/ams/87ANNUAL/techprogram/programexpanded_393.htm))